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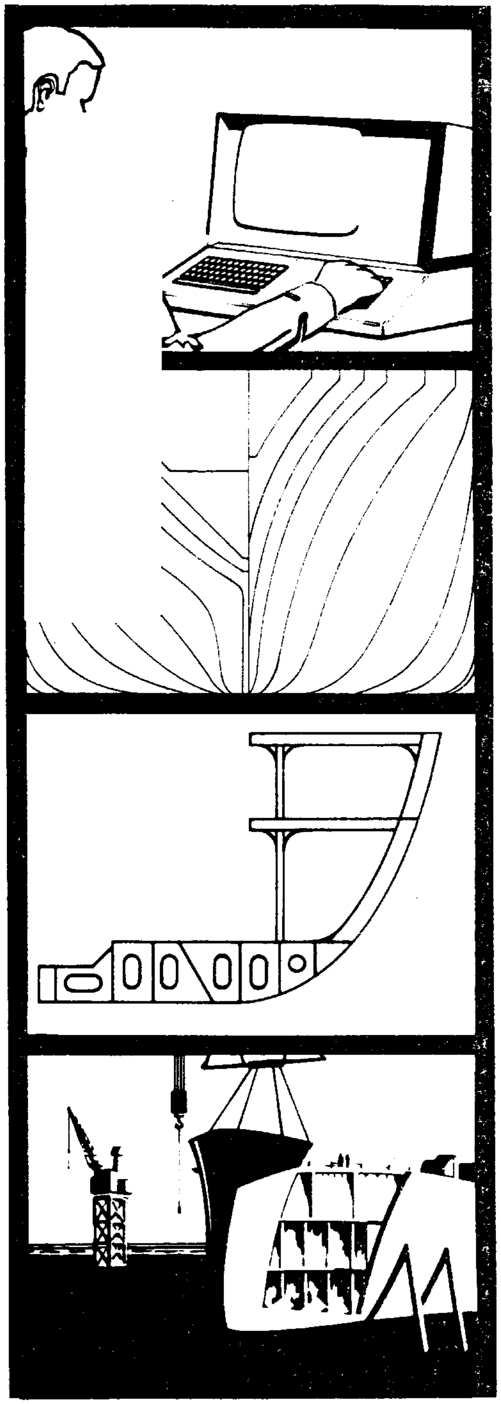

R ESEARCH
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CONSIDERATIONS FOR AN AUTOMATED

PIPE FABRICATION FACILITY

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New Orleans, Louisiana

Mr. Gatlin manages Avondale's plant engineering and maintenance activities. Before joining Avondale, he was a Lieutenant Colonel with the Army Corps oF Engineers. In this capacity, he was a facilities and equipment plant engineer in the Panama Canal Zone, a nuclear weapons officer, and a research electronic fire control engineer.

Mr. Gatlin has a Civil Engineering degree from Northwestern University of Florida and a Mechanical Engineering degree from the University of Alabama.

Approximately two years ago Avondale Shipyards, Inc., submitted a proposal to the U.S. Maritime Administration on the development of a semi-automatic pipe fabricating facility. This proposal was accepted and, since that time, we have been conducting an in-depth study of the subject.

Fabrication cost of ship piping systems is of a magnitude worthy of study, since it is roughly equal to one-fourth of the total hull cost of a ship. For a 176,000 DWT tanker, this amounts to approximately 200,000 man-hours of production. It is our opinion that through automation a percentage of the required man-hours can be reduced in the following functions: handling (65%), fitting (55%), welding (30%), cleaning (75%) and coating (85%). These percentages are based on LASH vessel construction since all of our original data is applicable to this series of ships. An overall percentage reduction in fabrication man-hours equates to approximately 37.5 percent per shipset. Therefore, it is conceivable that we could have fabricated each piping system for 25,000 man-hours as compared to our actual cost of 40,000 man-hours.

On vessels presently under construction at Avondale, savings through automation could be as high as 30,000 man-hours, or in excess of $420,000 per vessel, and we can complete three such ships per year plus five ships of the LASH type.

Our study has been conducted at our Main Pipe Shop and utilizes manual fitting, welding and burning as a base along with our original shop layout and flow diagram. We originally had a production capacity of 50 to 55 spool pieces per day with a complement of 76 people in this department. Basic changes which we have accomplished during this study, such as wire-feed welding in lieu of stock welding, provision of a cutting station, installation of contour cutting machines and utilization of a limited amount of turning and manipulation equipment, have increased our production to 60 to 65 spool pieces per day.

Before getting into the subject at hand, I would like to point out what pipe fabrication systems exist as the state of the art.

There are several equipment manufacturers in the world today who have

developed and are marketing automated pipe fabrication equipment for the shipbuilding and pipe fabrication industries.

Japan has two major manufacturers. First, is the Ishikawajima-Harima Heavy Industries Co., Ltd., or IHI, system which is very efficient, but is limited as to pipe diameter and to processing of steel pipe only. It provides storing, marking, flange fitting and welding, cutting, bending, loading and transferring capabilities.

Second, is the Mitsui Engineering and Shipbuilding Co. which has an existing system, called MAPS, similar to the IHI system, but is also limited as to pipe diameters and does not provide for alloy material. However, we feel Mitsui could provide for the complete shop, and they have done some outstanding planning and development work in this area.

IHI and Mitsui, as well as Hitachi Shipbuilding Co., Ltd., can provide software packages to support the required degree of automated hardware and material control. Mitsui's software package is very sophisticated and seems to provide more desirable features than any other existing system. It also has all capabilities for engineering requirements, including preparation of detail drawings. Therefore, it appears to be Mitsui's major marketing item.

The Maritime Administration has awarded a feasibility contract to Newport News shipbuilding and Drydock Co. for development of a software package which would provide engineering, including digitizing, in support of an automated design system. Avondale, in conjunction with Newport News, is studying the feasibility of integrating this system with the hardware system we are attempting to develop.

In Germany, oxytechnik has the capability to provide complete automated systems except for branch welding, sub-assembly type work and a software package necessary for engineering and control of equipment. This manufacturer has been extremely energetic in adapting to and meeting the requirement of, various types of pipe fabrication processes. Kockums Shipbuilding Company has developed an excellent program nicknamed “system Q" and "Steer Bear”, for use with the Oxytechnik system within their own pipe fabrication shops for production scheduling, engineering and material and machine control.

Mecaval International, in France, has developed a pipe shop system but it is limited to cutting, flange welding and numerically controlled bending and conveying equipment. St. Nazzair Shipyards has developed an outstanding fitting and welding system to support this Mecaval system.

In Sweden, ESAB systems have been limited to flange welding machines and manipulators. However, ESAB has developed exceptional welding equipment in the past and is presently studying the feasibility of utilizing their robot units in pipe welding. Preliminary data on this equipment indicate possibilities in this area.

Here in the United States, some welding technology has been developed along with pipe manipulators and turning devices.

We have visited many companies in the United States, and a few in Europe which are involved in processing pipe for chemical plants, oil refineries and pipe fabricating companies. In general, all pipe production we have witnessed is as inadequate, or backward, as it is in the shipbuilding industry, with some noteworthy exceptions.

We have concluded that there is not a single total automatic, or semi-automatic, pipe fabricating system available in the world today. Yet, most of the machines required for such systems are available in Europe, Japan, and the United States.

The primary objective of our study is to design a cost effective and automatic method of fabricating pipe which will reduce the labor, material handling, storage space and required fabrication area.

Such a facility for the shipbuilding industry must be designed to handle 1-1/2″ through 24″ diameter pipe and all ASTM Class I schedules and alloys of pipe used in shipboard systems. The facility must be versatile and equipped to handle repair jobs and specialty items, as well as new vessel piping systems.

The following functions represent a pipe fabricating system which can be

implemented along with certified procedures where necessary, either in part or as an entire system at any major shipyard.

1. Rather than random stacking and storage experienced in many areas, a systematic rack storage and locator system for all types of pipe, in sizes 1-1/2″ through 24″ must be established. The storage racks must provide for loading, selecting and off-loading onto a transfer system automatically.

2. A sorting and automatic feed system must be installed at the pipe storage rack so that an operator can automatically select pipe from the rack, load it onto a conveying system and convey it to the work station.

3. The automatic conveying system, for movement of pipe from one work station to another, must be equipped with an automatic unloading device at each station and a reserve area to hold pipe for each machine at the specific station.

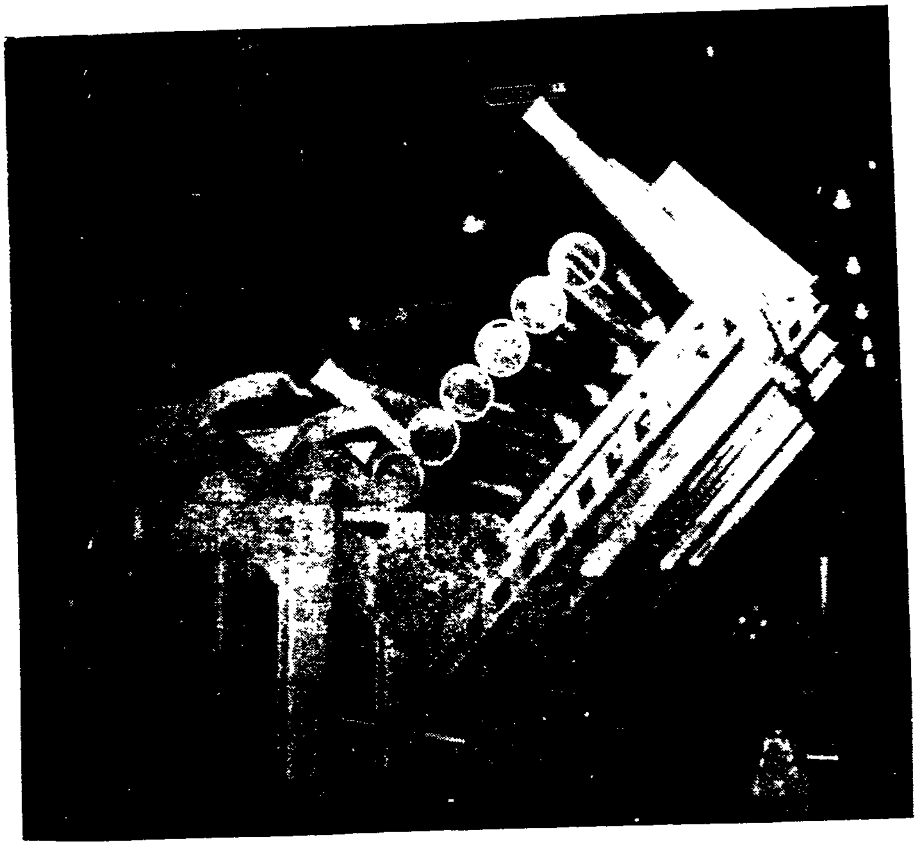
4. A measuring system must be installed to automatically measure pipe for cutting to length, locating holes and other layout requirements.

5. A system must be furnished to mark each component of the assembly with the specific part number as identified on the production drawings.

6. Cutting and end preparation machines must be provided. This function is extremely important since, in order to obtain good welding results, the use of machine cutting is an absolute necessity. At this point, all scrap must be conveyed out of the shop area by means of conveyors or other handling equipment.

7. An automatic flange fitting and welding device must be installed and have the capability to process the pipe alloy mix, as well as, select the flange, orient it properly, tack it and weld both inside and out.

8. Adequate numerically controlled bending equipment must be provided capable of two-diameter bending for up to schedule 80 pipe, 8 inches in diameter. Adequate bending facilities for larger pipe will depend upon the



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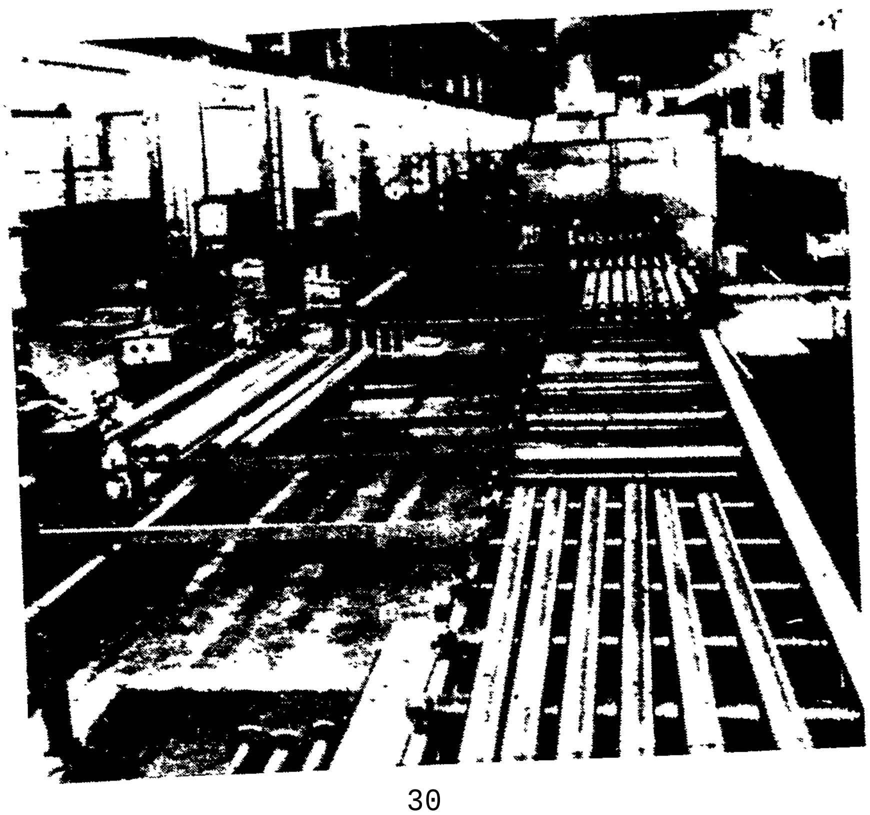

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number of ship systems for which larger pipe is required. It can be either hot bending or vibratory bending. An important function of this bending equipment, in addition to the two diameter bends for pipe up to 8 inch diameter, is the capability of being automatically fed and bent with flanges already welded on both ends.

At the present time, most bending machine manufacturers located in the United States appear not to be interested in designing equipment, or modifying existing equipment, to accommodate flanged pipe to be bent.

9. We must select the various types of welding equipment which will be required to process the mix of pipe going through the system, provide rolling devices for welding of straight pipe and incorporate automatic loading and unloading mechanisms as well. The development of semi-automatic welding devices for sub-assembly and assembly areas is a desirable procedure, along with certified welding procedures.

10. Assembly areas, in almost all establishments we visited, were the most labor dense and backward in terms of automation. In fact, in many shops, we wondered why management has not asked, "Why can't we improve this area a little?". Here manipulator fixtures must be designed so that assembly of Pipe sections can be processed in an effective manner. Manipulators are to be fitted with semi-automatic loading and unloading devices and must be capable of positioning the main body of pipe into position so that fitting and one pass welding can be accomplished. The welding devices should be selected and developed concurrently with the manipulator fixtures for this function.

11. Determine the configuration and quantity of X-Ray booths and equipment required to support the maximum work load of this work station and provide handling equipment required for loading, manipulating, and unloading the X-Ray booths.

12. provide for a semi-automatic internal and external blasting and coating system for pipe. A by-pass would also be provided so that all full length pipe, which does not require further processing, will be channeled directly to the assembly area.

13. Designate a specialty area for the fabrication of the inevitable "exception". We must select machines, tools and handling equipment for processing specialty items of a configuration and volume not suitable for automatic and semi-automatic processing. The specialty area will be situated so that it is accessible to the automatic conveying system. Generally, work in this area will be accomplished by hand.

14. We must provide a final product storage system where the fabricated pipe and specialty items can be palletized and stored in a racking system, in usage order, until required. A locator system, to be used for accountability and retrieval, should control the storage function. on.

15. Transportation and handling equipment must be provided for selection, load-out and delivery of fabricated pipe to the installation site.

16. The computer software package must be developed to support this fabrication shop, as our investigation has revealed that all man-hour savings, to be experienced by an automated system, can be completely offset by a major increase in the Engineering Staff necessary to provide the drawings and other data in a timely manner. Therefore, a computer software package must be developed to operate this system and have the capability of preparing pipe detail drawings. As these drawings are being prepared, the program should select required information from data banks which would allow the concurrent preparation of bills of material, shop production schedules, material flow schedules, cutting lists, assembly marking and bending data, machine loading schedules, and final disposition and delivery schedules.

We envision the use of a mini-computer, supported by a primary computer, which could utilize a digitizer or some other method to design, update and revise the various parts of the system.

The software package must be in the form best suited to the specific facility and working methods of the particular system, such as the order card for numerically controlled equipment, tape for tape controlled equipment, and numerical list for other equipment and manual operation.

In conclusion, let me summarize by conveying to you what we at Avondale expect the cost of implementation will be, what we expect to gain from our proposed automated system, and what approach we anticipate taking.

Without a doubt the cost of this facility will not be cheap. A system as described would cost anywhere from 2 million to 5 million dollars dependent upon existing shop facilities and the size and type pipe to be processed.

With an investment of this magnitude we can expect at least two things:

1. An extremely efficient pipe fabrication shop capable of meeting required production schedules. The system we contemplate is designed to produce 150 pipe spools per day with a corresponding limited reduction of skilled shop manpower. We expect that production will increase from one spool per man per day to 2.3 spools per man per day, including blasting and coating.

It should be noted that since we are a non-union yard the reassignment of personnel does not present the associated contractural problems.

2. An extremely cost effective pipe fabrication shop. As indicated at the outset, an improvement in man-hour cost of 37.5% can be realized. However, with all functions of the system operating, a 50 to 55% reduction in production cost is easily attainable in even the smallest of automated facilities we have seen.

Our approach must include the establishment of the required work stations and the development of the required welding techniques and procedures. Quite a bit of this has been achieved in our welding laboratory. Implementation in our production area is being accomplished as these systems and procedures are approved by the regulatory agencies.

We must be open-minded concerning old techniques which could lend themselves to automation and improve cost. One such item is the use of Van Sloan flanges with cold extrusions or “cold-necking” of steel, stainless steel, and copper nickel pipe in order to reduce the number of tees, weldelets, and welding otherwise required.

Finally, we must overcome a negative attitude toward change which would be intolerable. Fortunately, at Avondale our Pipe Shop personnel provide the prime stimulus in our improvement program. It is this motivation, this impetus on the part of management, the engineering staff and the production department that is necessary to make an automated system work, regardless of the numerous problems which are to be encountered.

I. PIPE STORAGE RACK

	PROPOSED	EXISTING
Cycle Time	1.5 Min.	10 Min.

Input Data
1. Pipe Diameter
2. Pipe Thickness

II. AUTO PUNCHING.

	PROPOSED	EXISTING
Cycle Time	2 Min.	5Min.

Input Data
- Punching Position
- Punching Letters

III. AUTO MARKING

	PROPOSED	EXISTING
Cycle Time	2 Min.	10 Min.

Input Data
- Pipe Diameter
- Marking Positions

IV. AUTO CUTTING

	PROPOSED	EXISTING
Cycle Time	2 Min.	10 Min.

Input Data
- pipe Diameter
- Cutting Position
- Cutting Shapes
- Sorting Destinations

V. AUTO FLANGE FITTING/WELD

	PROPOSED	EXISTING
Cycle Time (Includ Weld)	5 Min.	25 Min.

Input Data
- Position of Flange Holes
- Welding Space
- Tack Welding Conditions
- Welding Conditions
- Sorting Destinations

VI. BUTT WELDING

	PROPOSED	EXISTING
Cycle Time	6 Min.	30 Min.

Input Data
- Fitting Position
- Welding Conditions

VII. BEVEL CUTTING

	PROPOSED	EXISTING
Cycle Time	4 Min.	10 Min.

Input Data
- Cutting Position
- Cutting Speed

VIII. PIPE BENDING

	PROPOSED	EXISTING
Cycle Time (2 Bent Pipe)	4.5 Min.	10Min.

Input Data
- Angles
- Planes
- Positions
- Flange Hole Pitch Diameter

IX. BRANCH PIPE WELDING

	PROPOSED	EXISTING
Cycle Time	10 Min.	30 Min.

Input Data
- Fitting Position
- Welding Conditions

	PROPOSED	EXISTING
TOTAL:	37 Min.	140 Min.

NOTE: Samples taken on 4" Dia. Standard Pipe .160 Wall

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